The Deep South

Te Kōmata o Te Tonga

Contents

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Antarctica is a place of pristine beauty and is of huge significance to humanity. It is important that young New Zealanders not only appreciate this significance but fully understand the insight that Antarctica can provide into how Earth's environment is changing as a result of natural events and human activities.

The New Zealand Curriculum supports this ideal through the Visions of developing young people who are 'connected to the land and environment' and are 'contributors to the well-being of the New Zealand environment'. The Curriculum Principles state that the school should deliver a teaching and learning programme that 'encourages students to look to the future by exploring future-focussed issues such as sustainability'.

In May 2013, the New Zealand Government announced ten national science challenges that will be key areas of research over the next five to ten years; one of which is to 'Understand the role of the Antarctic and the Southern Ocean on our climate and our future environment'. It is therefore timely to engage students in Science concepts in the context of Antarctica.

The Deep South is a unit of work that is designed for the use within New Zealand at levels 4-5 of the Science Curriculum. It covers Achievement Objectives within the four strands of The Living World, Planet Earth and Beyond, Material World and Physical World. The unit also supports the development of the key competencies, particularly Thinking (through the consideration of current socio-scientific issues), Relating to others (through the inclusion of co-operative, group tasks, discussions and debates) and Participating and Contributing (through reflection on an individual's role within a global environment).

The unit of work includes teacher resource sheets that outline the learning and provide guidance to teachers with little or no experience of Antarctica. The student resource sheets include information, questions and a range of activities related to the lesson. The Deep South covers the topics of Antarctica's past, present and future and considers life in Antarctica and the connection to the rest of the world. This unit represents approximately 20 hours of class time. Additional resources are provided to support the implementation of this programme into schools.

I hope that students and teachers will find this unit engaging and will develop an appreciation for Antarctica and the science that occurs there.

Antarctica's place in the world—Teacher's sheet

The Big Idea

Antarctica is a remote, cold place that has an influence on the climate of the rest of the world.

Lesson Resources

- ◊ PowerPoint
- ◊ Student worksheet
- ◊ Torch, globe, beakers, potassium permanganate
- ◊ ice, lamps, icecream containers, measuring cylinders

Learning Objectives:

Describe Antarctica's location and explain how this position influences the climate there

Define temperature as a measure of kinetic energy

Explain the difference between weather and climate

Explain how Antarctica is connected to the rest of the world through ocean currents

Possible Student Questions:

Where is Antarctica?
Why is it cold?
What is Antarctica like in Summer?
How is Antarctica's climate connected to the rest of the world?

Keywords:

Equator, temperature, particles, kinetic energy, weather, climate.

Possible activities to include in lesson

Slide 5:

- Use globe and torch/lamp to illustrate that solar energy is distributed over a greater surface area at the poles
- Students can investigate how much ice melts when the angle of the light is altered

Slide 6:

- Compare the rate of diffusion of a few potassium permanganate crystals in a beaker of hot water and cold water. What can this tell you about the movement of particles at different temperatures?

1. Use the wunderground website (1) to access the daily data from the weather station at Scott Base. Students can plot the average temperature for the week for Scott Base and their city. Plot the temperature and wind speed and looking for a relationship

Slide 7:

- Clip "Getting dressed for Antarctica" is a good starting point for discussing cold temperatures.

Slide 8:

- View clip explaining how Antarctica is connected to the rest of the world through ocean currents (2)

Useful web links

(1) http://www.wunderground.com/weatherstation/WXDailyHistory.asp?ID=ISCOTTBA1

(2) http://www.pbslearningmedia.org/resource/nves.sci.earth.oceancirc/global-ocean-circulation/

Antarctica's place in the world

Learning Objectives:

Describe Antarctica's location and explain how this position influences the climate there

Define temperature as a measure of kinetic energy

Explain the difference between weather and climate

Explain how Antarctica is connected to the rest of the world through ocean currents

Why is Antarctica so cold?

Antarctica is cold because it is located at the Earth's pole and it receives less solar energy from the sun. The average temperature in winter in Antarctica is –60°C!

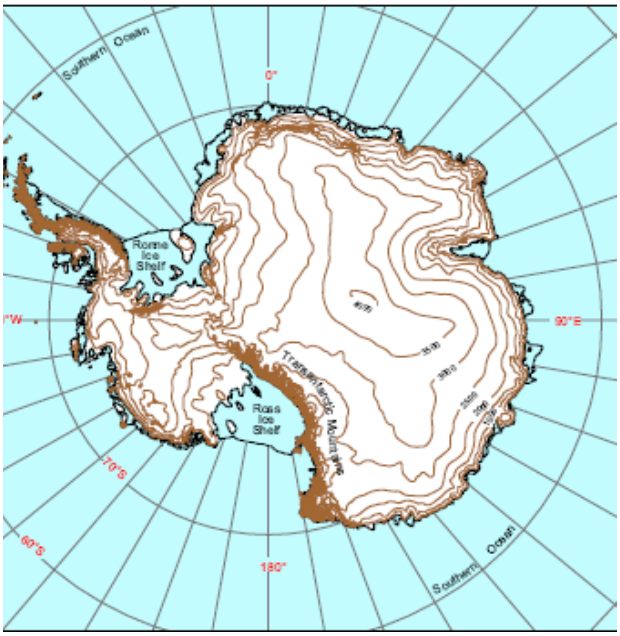
What is temperature?

Temperature is a measure of the average kinetic energy of the particles in an object or substance.

What is the difference between weather and climate?

Weather is the state of the atmosphere at a given place and time. Weather includes changes in temperature, winds, evaporation, cloud formation and precipitation (rain, snow, sleet and hail). The common weather experienced in Antarctica is high winds, blowing snow and very cold, dry air.

Climate is the average weather at a region over a long period of time. The climate in an area depends on the location on the globe, the altitude, winds, proximity to oceans and ocean currents.



Map of Antarctica (Source: AAD)

Exercises:

1. Draw a diagram and explain why Antarctica receives less solar energy from sun rays.
2. What does temperature measure? Describe the movement of particles in cold and hot objects.

Antarctica's connection to the rest of the world

1. Describe what the weather is like at the South Pole (Antarctica). Include such things as temperature, wind, rain, or snow.
2. List the clothing that you would take to Antarctica for a one week trip including amounts of each (i.e., 2 pairs of socks).
3. Explain why Antarctica is colder or warmer than where you live.
4. Explain the difference between climate and weather.
5. Describe what you think is the perfect climate for yourself and what activities you would like to do in that climate
6. What part does Antarctica play in the world's climate?

Investigation:

How does the angle of light affect the amount of ice that melts? Use a plastic container to hold 3 ice cubes. Different groups in the class should direct the lamp at different angles to the ice (keep the distance from the ice the same. After a set period of time, transfer any liquid in the container into a measuring cylinder to see which group had the most ice melting. The teacher may set up a "control" container with no lamp. What information would this provide?

The history of Antarctica—Teacher's sheet

The Big Idea: Antarctica was part of the large continent called Gondwana in the past. The process of plate tectonics has resulted in Antarctica moving over millions of years to its current position.

This has altered Antarctica's climate over time.

Lesson Resources

- ◊ PowerPoint
- ◊ Student information sheet
- ◊ Beakers, tripods, Bunsen burners, miso soup

Learning Objectives:

Describe the evidence that supports that Antarctica was once in a different location and climate

Discuss the driving forces behind the movement of Antarctica to its current position

Possible Student Questions:

What evidence is there that Antarctica was part of Gondwana?

What causes the movement of continents over time?

How was Antarctica different in past?

Keywords

Fossil, Gondwana, Pangaea, crust, mantle, inner core, outer core, convection current

Possible activities to include in lesson

Slide 4: Students can match images of Gondwana breaking up to statements (1)

Slide 5: View animation of Gondwana breaking up of the Te Ara website (2)

Slide 7: Students can make a fossil using the information worksheet available (3)

Slide 10: Extension/homework task: Antarctic sediment core activity. Students compare sediments from different regions in Antarctica and interpret a sediment core (4)

Slide 14: Students carry out an experiment to illustrate the convection currents in the mantle.

Other activities: Student could create a stop motion clip showing how Antarctica has changed over time using Windows movie maker—website "Slowmation" has resources, examples and lesson plans for teachers. (5)

Useful web links

(1) On the move resource sheet: www.discoveringantarctica.org.uk/resources

(2) http://www.teara.govt.nz/en/interactive/12410/break-up-of-gondwana

(3) Fossil casting: http://www.gns.cri.nz/index.php/Home/Learning/Science-Topics/Fossils/Lesson-Plans/4.-Fossil-Casting

(4) Sediment cores (Lesson 3): www.gns.cri.nz/Home/Learning/Science-Topics/Ice-Snow/Lesson-Plans

(5) http://slowmation.uow.edu.au/index.html

The history of Antarctica

Learning Objectives:

Describe the evidence that supports that Antarctica was once in a different location and climate

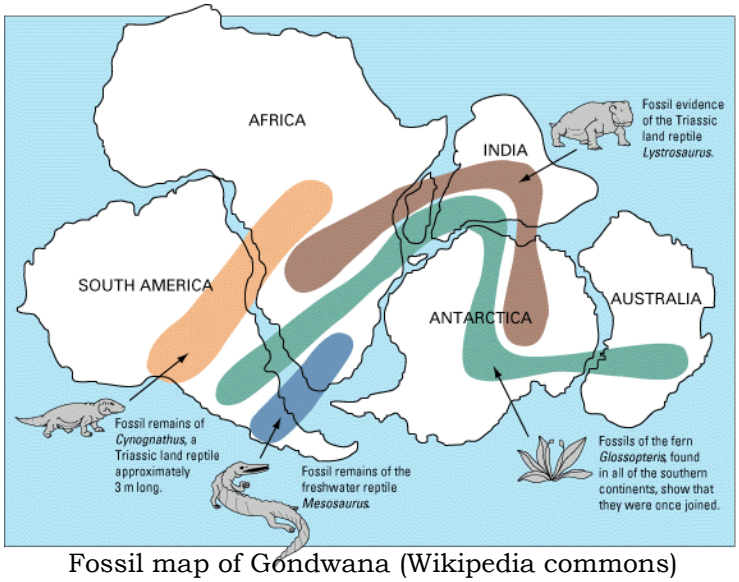
Discuss the driving forces behind the movement of Antarctica to its current position

Antarctica was once part of the supercontinent Pangaea. About 220 million years ago, Pangaea split up into Laurasia and Gondwana.

Laurasia eventually formed the Northern Hemisphere continents. About 150 million years ago Gondwana started breaking up into the continents of Africa, Australia, South America, India, New Zealand and Antarctica.
The continents continue to move at about a few centimetres a year – this is the same rate that your fingernails grow!

The evidence that the continents were once joined include :

- matching fossils on different continents,
- the shape of South America and Africa appear to fit together
- Matching ancient rock sediments on separate continents



Fossil map of Gondwana (Wikipedia commons)

Exercises:

1) What characteristics do you think enable a plant or animal to survive the breakup of a continent? Try to think of at least 2 characteristics.

2) Do you think that the breakup of Pangaea into Gondwana and Laurasia affected organisms originally living on Pangaea?

3) Do you think that the breakup of Gondwana into the southern continents affected the organisms living in Gondwana? What evidence supports your ideas?

4) Based on geologic past, we can assume that Earth is always changing. What modern-day evidence supports this idea? Hint: thing about natural disasters. Where do the often occur?

Investigation: Convection currents

Aim: To observe the convection currents that occur in the mantle of the Earth.

1. Set up tripod, gauze mat, Bunsen burner.
2. Fill a beaker with 150 mL of miso soup.
3. Heat the beaker of liquid and record your observations.

⇒ What part of the Earth does the miso soup represent?

⇒ Where does the heat come from to produce convection currents in the mantle?

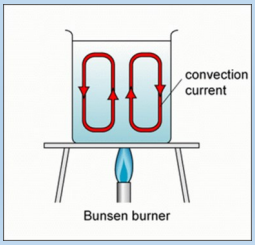


Image: Physics Faculty UHK

A Changing World —Teacher's sheet

The Big Idea: An increase in the amount of carbon dioxide in the atmosphere is changing the world's climate. Increasing temperatures cause ice to melt in Antarctica and sea levels to rise. The effects on Antarctica have global impacts.

Lesson Resources

- PowerPoint
- Student information sheet
- Frozen Ice "cores", universal indicator, base, syringes or droppers

Learning Objectives:

Explain how carbon dioxide travels in and out of the atmosphere

Describe what causes the greenhouse effect and what effects this has on Antarctica and the rest of the world.

Discuss the evidence from Antarctica that show the earth's climate has changed over time

Possible Student Questions:

What is the greenhouse effect? What is the carbon cycle?
How do scientists know there is more CO_2 in the atmosphere?
What is predicted for the future?

Keywords

Carbon dioxide, atmosphere, fossil fuels, greenhouse effect, climate, ice core

Possible activities to include in lesson

Slide 6: Students could act out the carbon cycle using the resource below (1). At each station they roll a dice to see where they travel to next.

Slide 9:

- Watch TED video (2) on "Antarctic Time Machine" (more technical than required) or clip on "RICE Project" (3)

Slide 11: Ice core experiment. Use ice core experiment sheet for students to record data. Freeze a different concentrations of acid in petri dish for each group. Most concentrated solution represents newest ice core layer. Students add universal indicator and add a base until the solution turns green.

Additional resources:

Antarctica and Climate change information (4)

Useful web links

(1) Act out Carbon cycle: http://oceanservice.noaa.gov/education/pd/climate/teachingclimate/carbon_cycle_game.pdf

(2) http://ed.ted.com/lessons/lee-hotz-inside-an-antarctic-time-machine

(3) http://www.youtube.com/watch?v=4_Lk0XmVPV8&feature=youtu.be

(4) Antarctica and it's role in climate change: http://www.gns.cri.nz/Home/Learning/Science-Topics/Ice-Snow/About-Ice-Cores

A Changing World

Learning Objectives:

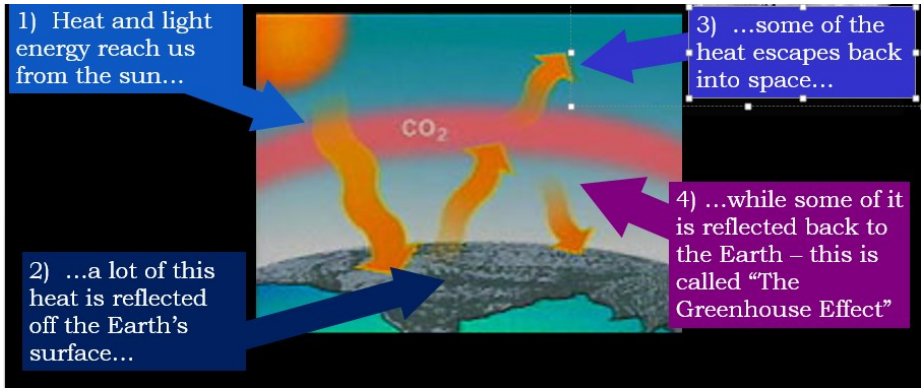
Explain how carbon dioxide travels in and out of the atmosphere

Describe what causes the greenhouse effect and what effects this has on Antarctica and the rest of the world.

Discuss the evidence from Antarctica that show the earth's climate has changed over time

The Greenhouse Effect

The greenhouse effect is a natural process where gases, such as carbon dioxide, trap some of the sun's heat and make the Earth a liveable temperature.



Changing the balance

The burning of fossil fuels and large scale deforestation is changing the balance of carbon dioxide in the atmosphere.

Antarctica's role

Trapped air bubbles in the Antarctic ice sheet contain atmospheric gases. By studying the gases trapped in the annual ice layers, scientists are able to work out what the Earth's atmosphere and climate were like in the past. By studying climate patterns in the past, scientist can make predictions for the future climate.

Image: www.noaa.gov

Exercises:

1. Explain what is meant by the "carbon cycle".

2. What are the processes that release and remove carbon dioxide from the atmosphere?

3. Ice cores are used to determine the concentration of carbon dioxide in the past. What other information can ice cores provide scientists with?

Experiment:

1. Take an slice of "ice core" . Add it to a beaker with 3 drops of universal indicator.
2. Fill a syringe or measuring cylinder with "carbon dioxide remover" (base). Add this to the beaker dropwise.
3. Stop when the solution turns green
4. Record how much base you added.

⇒ What does it mean if you need to add a lot of the base?

Life in Antarctica —Teacher's sheet

The Big Idea: The climate in Antarctica affects the life present there. The terrestrial environment has a comparatively low biodiversity and a low abundance of vegetation

Lesson Resources

- PowerPoint
- Student information sheet
- Algae, moss, lichen samples, microscopes

Learning Objectives:

Explain the requirements for life and identify challenges to life in Antarctica

Use scientific classification system to identify the types of life present in Antarctica

Possible Student Questions:

What are the challenges to life in Antarctica?

What is able to survive in Antarctica?

Where are living things found in Antarctica?

Keywords:

Kingdom, classification, moss, lichen, algae,

Skills:

Use of a microscope

Possible activities to include in lesson

Slide 2-3:

Students could produce a research poster or presentations on the smallest inhabitants in Antarctica.

Slide 8:

Further investigation on scientific classification is possible at this point.

Slide 9:

View the webcams present in Antarctica and have students look for any wildlife. This will obviously depend on the time of year and whether there is any sunlight in Antarctica!

Slide 11:

Recap the requirements for life with students before they start the brainstorm on challenges in Antarctica

Slide 12:

Have students search around the school for moss, lichen and algae to collect or photograph. Samples can be viewed in the classroom under the microscope.

Webcam links

http://antarcticanz.govt.nz/scott-base/current-conditions

http://www.antarctica.gov.au/webcams

http://www.antarctica.ac.uk//images/webcams/

http://www.usap.gov/videoclipsandmaps/mcmwebcam.cfm

Life in Antarctica

Learning Objectives:

Explain the requirements for life and identify challenges to life in Antarctica

Use scientific classification system to identify the types of life present in Antarctica

Antarctica's climate is harsh and only the hardiest can survive. On land you might find some lichen, moss and fungi. Land animals are limited to invertebrates such as the springtail, nematodes and mites.

Although seals and penguins spend some time on land, they are classified as marine animals. There are many other examples of life that can be found in the Southern Ocean

Examples of life in Antarctica

Images: Waikato University, Wikimedia, Bryon Adams

The Five Kingdoms

Most scientists agree that life can be separated into five categories (called kingdoms) with similar features. These kingdoms are: animal, plant, fungi, protist and prokaryota. The protist kingdom includes algae and microorganisms. The prokaryota kingdom includes bacteria and blue-green algae.

Exercises

1. What kingdoms are represented in Antarctica? Why are some kingdoms not represented?

2. Describe the observations made from the webcam. What would you expect to see in six months time?

3. What is lichen? How is lichen and algae different from plants?

Investigations:

1. Use the internet and textbooks to collect images of lichen, moss, fungi and algae (one from Antarctica and one from New Zealand). Research the characteristics of each.

2. Explore the school and collect photographs and samples of moss, lichen, algae and fungi

3. View the samples you collect under the microscope and record your observations!

Adaptations — Teacher's sheet

The Big Idea:

The organisms present in Antarctica are specially adapted to the conditions. These organisms are often unique to Antarctica.

Lesson Resources

- PowerPoint
- Student information sheet
- Selection of seafood (shellfish, crustaceans etc.)
- M&Ms, chopsticks, pegs, plastic cups, bowls
- Selection of different seafood

Learning Objectives:

Describe the adaptations that allow organisms to survive in Antarctica

Possible Student Questions:

How is life able to survive the harsh conditions on land and in the water?

What might change in the future as the world's climate alters?

Why is it important to protect the life found in Antarc-

Keywords:

Adaptation, organism, structural, behavioural, Physiological, antifreeze, competition, habitat

Possible activities to include in lesson

Slide 5:

Further information on the adaptations available from Gateway Antarctica (1)

Slide 7:

Have a selection of seafood available for students to view. Students can examine them and identify unique adaptations.

Slide 8:

Changing environment— discuss possible changes as a result of climate change—will some animals become extinct? Move further north? Will other plants and animals now be able to survive in Antarctica? More competition?

Slide 9:

Adaptation challenge—Introduce the students to the concepts of ecological niche and competition.

Additional activity: Watch David Attenborough's Frozen Planet and identify animal adaptations.

Useful web links

(1) http://www.anta.canterbury.ac.nz/resources/adapt.html#Fish

Adaptations

Learning Objectives:

Describe the adaptations that allow organisms to survive in Antarctica

Animals live in **habitats** that provide them with the food, shelter and water needed to survive. They also depend on special features called **adaptations** that help them to:

- Obtain food
- Defend themselves from predators
- Build homes
- Survive in extremes of weather
- Attract mate

Adaptations can be **structural** (something the organism has); **behavioural** (something the organism does); **physiological** (something it can produce –chemical).

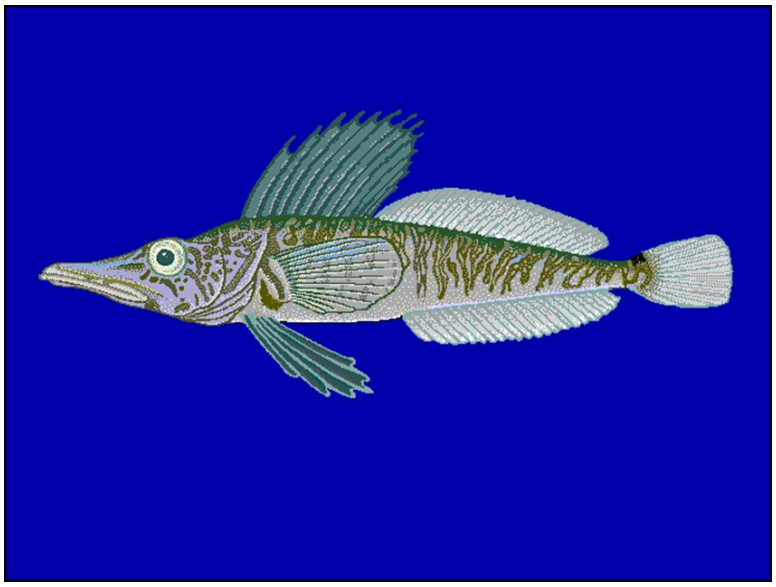


image :http://www.fishbase.org

Exercises:

1. The Icefish is an interesting organism found in the Southern Ocean. Identify 3 unique adaptations of the icefish that help it to survive in its habitat
2. Complete the following table:

Leopard seal	Emperor penguin	Killer whale
Name a structural adaptation	Name a behavioural adaptation	Name a structural adaptation
Explain how each adaptation helps the animal to survive in its environment		

3. Observe the range of organisms available from your teacher. Record as many adaptations as you can for each animal and describe how this adaptation helps it to survive.

Adaptation challenge!

1. Adelie and Emperor penguins both live in Antarctica and swim in the ocean to find food.
2. Divide into groups of six. Half the group will be Adelie penguins and the others Emperor penguins
3. Give Adelie penguins a peg and Emperors a pair of chopsticks (this represents the beak – a *structural adaptation)*
4. The food source is a bowl of coloured m&ms. The stomach is a plastic cup.
5. Students have 1 min to "fish" for food and fill their stomach!

Add up the nutritional value after the minute is up

What penguin was best suited to feeding in this task?

Antarctic ecosystems — Teacher's sheet

The Big Idea:

Organisms are connected with an ecosystem. Antarctic food webs are simple compared to most other ecosystems.

Lesson Resources

- PowerPoint
- Student information sheet
- Access to computers/internet

Learning Objectives:

Construct a food web based on an Antarctic ecosystem

Describe how Antarctic ecosystems may be affected by climate change and discuss the wider global implications

Possible Student Questions:

What animals are present in the marine ecosystem?
How is a food web constructed?
How do Antarctic food webs compare to other ecosystems?
How might climate change affect Antarctic ecosystems?

Keywords:

Ecosystem, habitat, food web, food chain, producer, consumer, organism

Possible activities to include in lesson

Slide 3:

For some classes you may want to extend the definitions to include primary and secondary consumers.

Slide 6:

Students could complete as many food chains as they can from the food web.

Opportunity to investigate the wider implications of changes in an ecosystem as a result of climate change, over-fishing etc.

Slide 7:

Students research and produce two food webs for different environments. Emphasise that Antarctic food chains are often much shorter than other ecosystems. What are the implications of this?

Slide 8:

Introduction to some of the challenges involved in Antarctic research. Students can develop creative ways of collecting information on a seal's diet when direct observation is challenging.

Useful web links

Short flash activity on Antarctic food webs: http://www.discoveringantarctica.org.uk/multimedia/flash/4_eating.html

Antarctic ecosystems

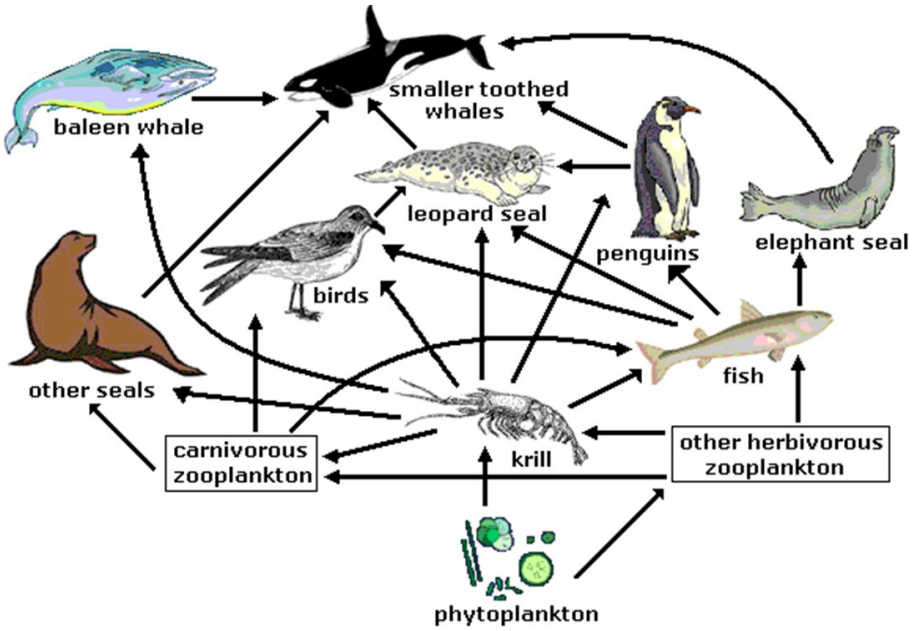
Learning Objectives:

Construct a food web based on an Antarctic ecosystem

Describe how Antarctic ecosystems may be affected by climate change and discuss the wider global implications

Food chains and food webs

A **producer** is an organism that is able to make its own food by using light energy from the sun e.g. plants and some bacteria. A **consumer** is an organism that eats other organisms to gain energy. Food chains and food webs always start with a producer. They show the flow of food energy, so the arrow always points away from the organism being eaten and towards the animal that is eating it!



Source: Wikispaces public domain

Exercises:

1. What are the shortest and the longest food **chains** in this food **web?**
2. What do leopard seals eat?
3. What would happen to birds if the number of zooplankton decreased?
4. What would happen to the other organisms if there were more fishing boats catching more fish
5. Krill is one organism that could be negatively affected changes in the environment due to climate change. What impacts would a decrease in the krill population have on (i) the Antarctic ecosystem and (ii) humans?

Research:

Use the internet or reference books to construct two food webs for two **different** environments.

You could consider:

- New Zealand bush
- African Savanna
- The Pacific Ocean
- The Australian outback
- Another suitable environment

Each food web should begin with a **producer**, include at least 10 different organisms (with images) and include arrows that show the direction of energy flow.

Ocean acidification — Teacher's sheet

The Big Idea: More carbon dioxide in the atmosphere results in the oceans becoming more acidic. This has implications for the life in the ocean, particularly organisms with carbonate shells

Lesson Resources

- PowerPoint
- Student information sheet
- Practical activity requirements

Learning Objectives:

Explain what an acid is and how the pH scale and indicators are used to identify acids

Describe how increased carbon dioxide in the atmosphere makes the ocean more acidic

Describe the effect of more acidic conditions on shelled organisms

Possible Student Questions:

What is an acid?
How does carbon dioxide make the oceans acidic?
What happens when acids react with carbonate shells?
What predictions are made for the future and how will these affect marine organisms?

Keywords

Acid, base, pH, litmus, universal indicator, neutral, corrode, calcium carbonate

Possible activities to include in lesson

Slide 3:

Additional practical activity: Test a selection of substances using litmus/ universal indicator

Slide 5 :

Identify initial pH of salt water. Students blow into salt water for a few minutes and monitoring pH change.

Slide 9:

As an alternative to having students plan and carry a reaction between acid and calcium carbonate shells, shells that have been soaking in weak and strong acid overnight (or longer) could be tested for strength relative to shells that have been in neutral water.

Slide 10:

Press release could be read as a cooperative reading task in small groups. Students identify key words and summarise the article (1)

Useful web links

(1) Article: http://www.antarctica.ac.uk/press/press_releases/press_release.php?id=1976

Ocean acidification

Learning Objectives:

Explain what an acid is and how the pH scale and indicators are used to identify acids

Describe how increased carbon dioxide in the atmosphere makes the ocean more acidic

Describe the effect of more acidic conditions on shelled organisms

Acidity

You have probably used some acids in the lab, but there are also many examples of acids around us everyday. Acids have a sour taste and can corrode ("eat away") metals! Acids contain an excess of hydrogen ions (H^+).

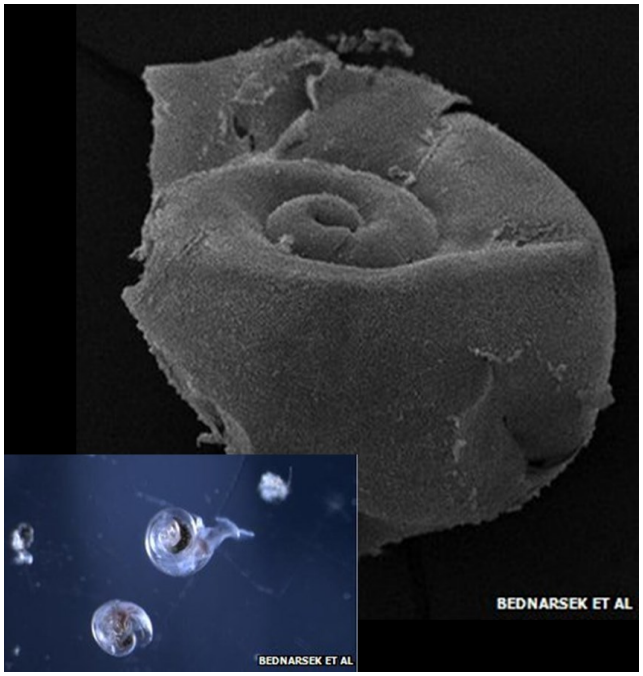
Bases feel slippery and contain fewer hydrogen ions than acids. They contain more hydroxide ions (OH^-). Soaps and bleach are examples of bases. When an acid is added to a base, it becomes more acidic.

pH Scale

The pH scale ranges from 0 – 14 and it measures how acidic or basic a solution is. A solution with a pH of 7 (such as pure water) is neutral, solutions above 7 are basic and solutions with pH below 7 are acidic. Universal indicator can be used to compare the strength of acids by showing the exact pH of solutions.

pH and the ocean

The ocean contains salt water and absorbs carbon dioxide from the atmosphere, as part of the carbon cycle. When the ocean absorbs carbon dioxide, it forms carbonic acid and the pH decreases.



Evidence of sea snail *(pteropod)* shells dissolving in the Southern Ocean . Source: BBC

Exercises:

1. Draw the pH scale and colour it according to the colours seen with universal indicator.
2. Why is it important to monitor the pH of rivers, lakes and the ocean?

Activity: Measuring pH

1. Take a boiling tube and partially fill with seawater
2. Add 2-3 drops of universal indicator
3. Record the colour and pH
4. Using a straw, slowly exhale into the tube of seawater for 2 minutes

Record the pH and colour and repeat step 4

Experiment: Acid and carbonate reaction

Plan and carry out an experiment to investigate the effect of acidic conditions on calcium carbonate shells.

Extended writing:

Write a short article for a student newsletter explaining what ocean acidification is and why the discovery of these deformed sea snail shells is very concerning for marine ecosystems.

Ice! — Teacher's sheet

The Big Idea: Antarctica contains 90% of the world's fresh water in the form of the ice sheet, ice shelf and glaciers. As the global climate changes and temperatures increase the ice in Antarctica melts.

Lesson Resources

- PowerPoint
- Student information sheet
- Clay/plastercine, plastic containers, ice cubes

Learning Objectives:

Explain the connection between different forms on ice in Antarctica

Describe the implications of increases in temperature on the ice in Antarctica.

Describe the local and global effects of an increased rate of melting in Antarctica

Possible Student Questions:

What is the difference between glaciers, ice caps, ice shelves and icebergs?
What annual and long term changes to ice in Antarctica have been observed?
Does Antarctic ice show a similar decline to Arctic ice?
What are the implications of melting ice cap on the rest of the world?

Keywords

Ice sheet, ice shelf, sea ice, glaciers, precipitation.

Possible activities to include in lesson

Slide 5: Watch an animation of sea ice formation in Antarctica (1)

Slide 6: Cooperative reading task. Antarctica—The frozen continent (2) This could be substituted for a relevant news article on glacier melt rates.

Slide 7: Students construct a model using the template (3) to illustrate how ice moves from inland towards the ocean.

Slide 8: View the collapse of the Larsen B ice shelf from satellite images. Discuss what the effects may be using the ice model help guide students.

Slide 9: Sea level rise experiment: detailed information on this experiment available online (4)

Additional activities:

Worksheet "Introduction to Antarctica" (3) could be homework or revision

National geographic clip (5) - discusses melting glaciers and ice sheets.

Useful web links

(1) http://www.youtube.com/watch?v=GHvrjX7AP-8

(2) Antarctica – Frozen continent: www.discoveringantarctica.org.uk

(3) Ice flow model : www.gnx.cri.co.nz/Home/Learning/Science-Topics/Ice-Snow/Lesson-Plans

(4) http://www.calacademy.org/teachers/resources/lessons/global-climate-change-and-sea-level-rise/

(5) http://video.nationalgeographic.com/video/antarctica-ice

Ice!

Learning Objectives:

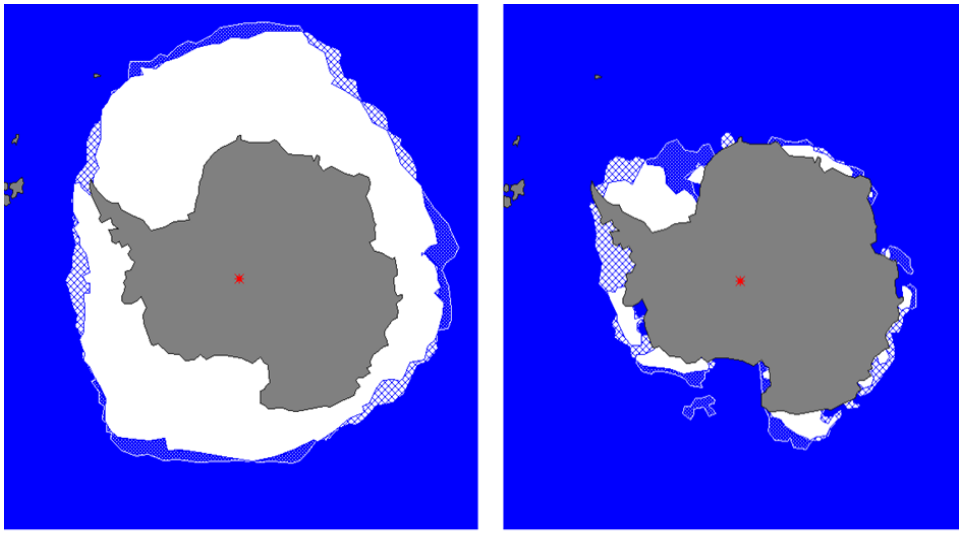
Explain the connection between different forms on ice in Antarctica

Describe the implications of increases in temperature on the ice in Antarctica.

Describe the local and global effects of an increased rate of melting in Antarctica

Ice everywhere!

98% of the Antarctic continent is covered in ice. This ice is not all the same. Ice covering land is formed from the compaction of snow over time and is called the **ice sheet**. Some of the ocean surrounding Antarctica remains permanently frozen (**ice shelf).** Ice shelves are connected to the ice sheet. Every year in Winter the **sea ice** extends north, doubling the size of Antarctica. In Summer as temperature increase, the sea melts again. A **glacier** is a slow moving river of ice that moves from inland towards the ocean.



View of Antarctica sea ice surrounding the continent in September and February. Source: NASA

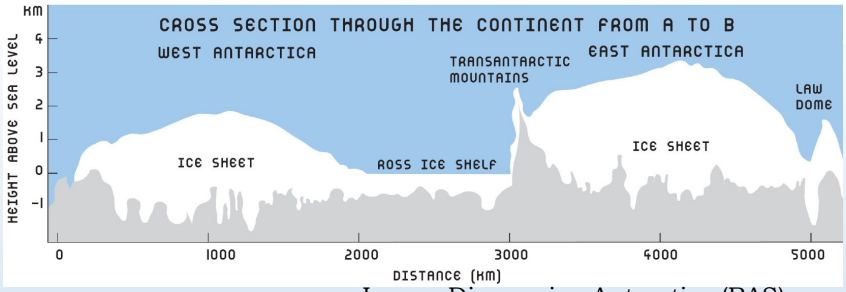


Image: Discovering Antarctica (BAS)

Exercises:

1. List three differences between the ice sheets over West Antarctica and East Antarctica. Think about their size, the heights of the ice sheets and the land below them.
2. If Antarctica's area is about 14,000,000 square kilometres and the average ice sheet thickness is 2,450 metres, can you calculate the approximate volume of the ice in Antarctica?
3. What do you think would happen to the land buried under the ice if the ice sheets melted? Why?

Investigate: Sea level rise

Aim: To compare the effect on sea levels when glaciers and ice shelves melt

Set up 2 plastic container with clay or plastercine down one end to represent the land

1. Add 6 ice cubes onto the "land" in one container and 6 ice cubes on the base of the container in the other.
2. Add water to each container. Ensure the ice at the base of the container is floating.
3. Mark the level of the water on the outside of the container
4. Measure the level of the water again once the ice has melted and record the change for each container

Energy on the continent — Teacher's sheet

The Big Idea:

There is a financial and environmental cost to producing energy in Antarctica. Increasingly renewable energy sources are being used.

Lesson Resources

- PowerPoint
- Student information sheet
- Class access to the internet for research
- Solar cells, lamps, multimeters

Learning Objectives:

Compare different ways of producing energy and identify any challenges for the Antarctic environment

Discuss the most suitable forms of energy to use in Antarctica

Possible Student Questions:

How do science bases in Antarctica produce energy to operate?
What renewable energy is used in Antarctica?

Keywords:

Energy, joules, renewable, non-renewable, solar, wind turbine, fossil fuels, geothermal, nuclear, hydroelectric

Possible activities to include in lesson

Slide 4:

It is presumed that students have covered different forms of energy and energy transfers prior to this lesson. Some additional information may be necessary for students who have not covered this.

In this slide students identify as many sources of energy as they can. The images act as a prompt for this discussion but other forms of energy could be included.

Slide 5:

This is an opportunity for experiment planning and could be run as an a assessment of practical skills.

Slide 6:

Some science bases in Antarctica run on 100% renewable energy sources. Students could identify these bases and determine whether this is feasible for all of Antarctica or New Zealand

Useful web links

Information of Scott Base and the Meridian wind farm in Antarctica available at: www.antarcticanz.govt.nz

Energy on the continent

Learning Objectives:

Compare different ways of producing energy and identify any challenges for the Antarctic environment

Discuss the most suitable forms of energy use in Antarctica

Energy on the continent

Antarctica is a cold, harsh environment and it takes a lot of fuel to support the people who work and live there.

It is expensive and time consuming to transport fossil fuels to Antarctica by ship. There are also environmental problems and risks associated with fossil fuels.

Some countries are using other forms of energy in their science bases.

Fossil fuels are **non-renewable** energy sources because eventually they will run out. Wind and solar energy are examples of **renewable energy** sources.

Wind turbines located between Scott Base and McMurdo Bases.

Exercises:

1. What is energy measured in? Give the energy transfers involved in the following:

A radio, a television, a torch, a tennis ball bouncing, a heater, a wind turbine, s solar cell

2. How is electricity generated in New Zealand? Identify the renewable and non-renewable sources of energy?

Planning an experiment: Energy from solar cells

Solar cells are devices that convert light directly into electricity. A voltmeter can be used to measure the voltage generated by solar cell. An ammeter is used to measure the electrical current from a solar cell.

Your task is to plan an experiment that will investigate how the voltage and current changes when the solar cell is at different distance from the light source.

Identify the Independent variable, dependent variable(s), control variables.

Research: Energy in Antarctica

Investigate the following questions:

What are the advantages and disadvantages of renewable energy sources (e.g. solar, wind) and non-renewable sources (e.g. fossil fuels)?

What energy sources are suitable for use in Antarctica? Why?

Find examples of three science bases in Antarctica. Compare how these bases produce energy for the people who live and work there.

Produce a brochure for the government outlining energy options for Scott Base

An eye on the future — Teacher's sheet

The Big Idea: Antarctica is a place for peace and science but in the future there will a number of challenges to face. One of these challenges is an increase in world population and an increased demand on resources.

Lesson Resources

- PowerPoint
- Student information sheet
- Cookies,

Learning Objectives:

Identify some of the resources available in Antarctica

Discuss the future for Antarctica and the resources present there

Possible Student Questions:

What are some of the challenges that might face Antarctica in the future?
Why is mining prohibited in Antarctica? Should this be the case in the future?
How can the Antarctic environment be protected in the future?

Keywords:

Minerals, exploration, Treaty, mining, drilling, resources.

Possible activities to include in lesson

Slide 4:

Students could spend time investigating what resources are present in Antarctica. Consider what conditions in the future may make accessing Antarctic resources a likelihood? This could involve discussions on the development of adequate technology to make it feasible or simply a much greater demand for energy and fresh water.

Slide 5:

Students should consider why it is important to preserve the environment. They can explore their values around the environment and consider why they hold these values.

Slide 6:

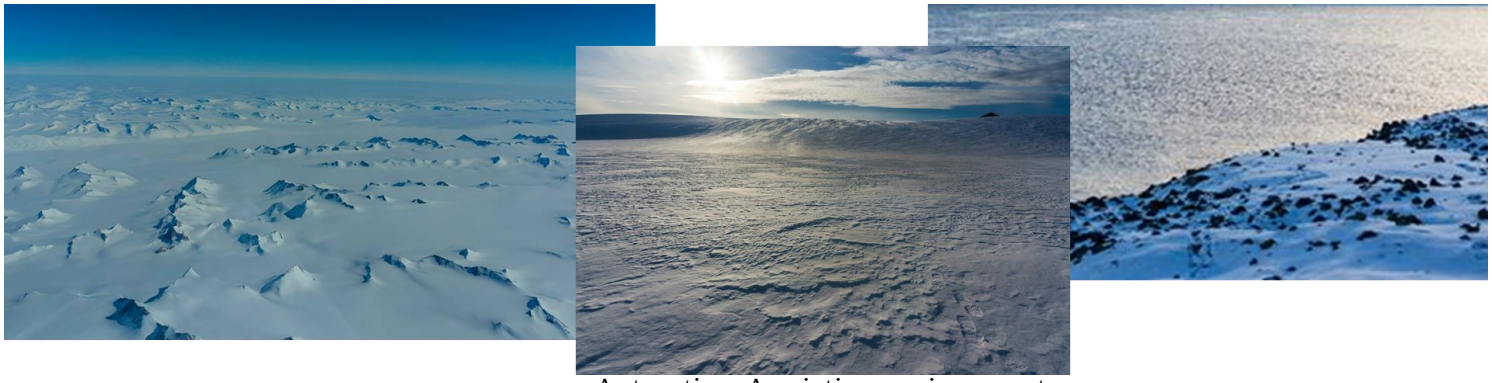
In this activity students can assume the role of either a Treaty or non-Treaty signatory. How might the interests of these groups differ?

An eye on the future

Learning Objectives:

Identify some of the resources available in Antarctica

Discuss the future for Antarctica and the resources present there



Antarctica: A pristine environment

Antarctica is not owned by any one country.

The Antarctic Treaty protects the continent from mineral exploration (mining) and conflict. Antarctica is reserved as a place for science and peace.

A 'resource' is something which is useful. Can you think of some of the resources that are or may be present in Antarctica? Resources in Antarctica are protected by the Antarctic Treaty.

Exercises:

1. Mining and drilling for oil is prohibited – why do you think these activities are banned?
2. Why might the ice in Antarctica be considered a valuable resource?

Activity: Mining for chocolate

Imagine that in the future countries are able to collect mineral resources in Antarctica.

In this activity the mineral resource is chocolate! Each group will have to collect as much chocolate as possible from the cookie within the time limit…using whatever method they choose.

Once you have finished, think about this:

What are some ways you could "cheat" at this task to ensure you win?